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(NASA-CR-149348) [REMOTE SENSING OF
WETLANDS, MARSHES, AND SHORELINES IN
MICHIGAN INCLUDING ST. JOHN'S MARSH]
Semiannual Status Report, 1 Jun. - 1 Dec.
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ERIM

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SEMI-ANNUAL STATUS REPORT, 1 June 1976 to 1 December 1976

NASA Grant NGR 23-005-552

Principal Investigator: Donald S. Lowe

This report covers recent progress in a program sponsored by the NASA Office of University Affairs to develop and demonstrate operational applications of remote sensing to land and water resource problems in Michigan.

During this semi-annual report period, our program was concentrated on accomplishing the following results:

- Remote sensing information supplied to the Michigan Department of Natural Resources on the St. John's Marsh has been used to document the unique character of the Marsh as a basis for accelerating plans for public acquisition of the Marsh and for preparing an environmental impact statement needed to commit federal funds to the acquisition project.
- The same remote sensing data base was used by DNR in its findings of facts which led to denying a permit for a project to build 500 apartments on 62 acres of wetlands in the marsh. If the developer starts litigation to overthrow the permit denial, the remote sensing data is likely to be used in court to uphold DNR's position.
- The NASA grant participated in the development of specifications for collection of 1:24,000 scale color infrared photography of Michigan which will be used for preparing a statewide wetlands inventory, forest mapping, and other purposes.
- The NASA grant is providing continuing consultation on the use of Great Lakes shoreline recession rate methods previously developed by ERIM. Under separate funding by DNR, ERIM is continuing a project for preparation of a Great Lakes shoreline atlas based on shoreline remote sensing data collected by the project in 1974.

- The NASA grant is assisting the Public Health Department of Washtenaw County in identifying cottage sites on five inland lakes which are suspected of having problems with septic tank operation.
- Plans and procedures have been set up which could be used to identify breeding habitat in any future program in Saginaw, Bay, and Midland Counties for controlling mosquitos responsible for the spread of St. Louis encephalitis.
- Assistance was provided to the leader of the Superior Shoreline Knapsack Trek for trip planning and route selection.
- The NASA grant cooperated with the Ann Arbor Police Department by using thermal mapping data to locate a site where previously disturbed earth indicated that bodies might be buried.
- The NASA grant is cooperating with the Director of the Michigan Space Center at Jackson Community College in recommending exhibits of NASA space accomplishments for display to visitors to the Center.
- The NASA grant is cooperating with the Office of Economic Expansion of the Michigan Department of Commerce in planning an industrial atlas for use with prospective clients considering locating or expanding industrial facilities in Michigan.

ST. JOHN'S MARSH

Michigan is in danger of losing St. John's Marsh and the problem is money. The State must find sufficient funds to purchase this ecologically valuable area in order to prevent the disappearance of this last large block of undisturbed wetlands along the American shoreline of Lakes Erie and St. Clair. It is an important spring and fall feeding and resting area on a major continental waterfowl migration route and a major fish nursery.

The marsh is also important because of the proximity to the population of SE Michigan. Nearly 5 million people live within a 1 or 2 hour drive of the marsh which is located in a part of the State that currently has only 1.5% of the State's total recreational land yet 50% of its population.

Federal monies are available through the Bureau of Outdoor Recreation to match State funds on a 50-50 basis, but the State has been unable to generate any funds at all for the last three years. This worries present landowners in the area. They cannot realistically be expected to hold title to lands in the marsh and pay taxes on it in an undeveloped state indefinitely. They don't want to serve as caretakers for land that benefits primarily the public.

To add to the impetus to resolve the problem, the Clay Township board has stated that they favor development because of the increase in tax base this would produce. As a result local rezoning for residential development has been approved.

The DNR, however, must approve the permit for dredging and filling necessary to prepare sites for development and they intend to block development insofar as possible. While this holding action is being carried on by the Water Management Division, the Wildlife Division has taken the lead in developing a plan to speed the public acquisition of the marsh. Several things have happened that make this more feasible than in the near past. First, the State Duck Stamp Act was passed last year,

requiring that every waterfowl hunter buy a \$2.10 stamp which generates funds earmarked for wetlands acquisition. This is expected to produce \$200,000 annually. Secondly, the Lake St. Clair Advisory Committee has begun a "save the marsh" fund drive which raised over \$20,000 in contributions from concerned citizens.

The Grant program has been involved in providing factual data, based upon remote sensing imagery, showing the strategic relationship of the marsh to population centers of SE Michigan and potential ecological consequences of its loss. In addition, the impact of past development on the area and changing lake levels have been identified through a comparison of the condition of the marsh in 1938 and 1974 via analysis of aerial photography collected during those years. During the current reporting period, ERIM remained in close contact with DNR agencies concerned with the preservation and acquisition of the marsh and provided any information needed in support of these activities.

Developer's Permit Denied

The most immediate threat to St. John's Marsh is from a local developer who wants to build 500 apartments on 62 acres of wetlands in the marsh, which are to be filled with dredged material to provide suitable building sites. The apartments are to be of the luxury condominium type each having its own boatwell. The project is attractive to Clay Township because it would bring nearly \$400,000 annually in taxes, plus \$691,000 in sewer fees and \$230,000 in water tap-in fees.

As a first step the developer filed a permit under the Inland Lakes and Stream Act to dredge boatwells, construct seawalls, backfill and level existing dredged spoils partly on an existing channel off the North Channel. A public hearing was held in Algonac on August 10, 1976. Subsequently, the Water Management Division reviewed the permit testimony and its own data, including that supplied through the grant, and decided to deny the permit.

Nineteen grounds were given for denying the permit including irreparable damage to fish and wildlife habitat. One of the significant points in the context of this report was that the area is "deep marsh and open water" as defined by state and federal wetlands classification systems and determined in a survey of the area prepared by ERIM using remote sensing data.

This is the present state of affairs. The developer has indicated that he intends to start litigation to overthrow the permit denial. In the event he does the DNR will probably be called on to defend its position in court. If this is the case the remote sensing data will probably be introduced as evidence for justifying the DNR's decision.

Marsh Acquisition Plan

Last summer St. John's Marsh was rededicated, this time as a wildlife refuge area. Previously, two years ago it was dedicated as a recreation area with a plan proposed to make it an ecological park for day-use only. Since the funds to purchase the area apparently are going to come largely from sportsmen, particularly waterfowlers, the decision has been made to dedicate the area to this more traditional use. This will also make initial administration of the area simpler because it can be operated as a satellite area of the existing St. Clair Flats State Wildlife Area. Two significant pieces of legislation passed this year which finally make it possible to get moving on acquiring parts of the marsh. The first is the Duck Stamp Act, which it is estimated will produce \$200,000 annually for the purchase of wetlands. The second is the Heritage Fund Act which stipulates that the royalties on mineral and oil leases will be applied toward state purchase of high value natural and recreational areas. Between these two acts, it is estimated that \$500,000 will be available this year as state generated funds for purchase of land in St. John's Marsh.

At the same time it should be possible to obtain an additional \$500,000 through a matching arrangement with the Bureau of Outdoor Recreation from their Land and Water Funds. This means nearly \$1,000,000 will be available this year.

Two parcels of land have been singled out for acquisition this first year. The first priority is the St. John's Family property consisting of 832 acres inside M-29. Second priority is the Blue Water Isles property on the west side of M-29, adjacent to Lake St. Clair (see Figure 1). It is anticipated that purchase of the St. John's parcel will require most of the \$1,000,000 available this year.

The NASA grant program has an important role in helping the state acquire the Marsh. Before BOR Land and Water Funds can be requested to match state monies an Environmental Impact statement must be prepared to show what effect the proposed action will have. In justifying the need to spend public monies to acquire the marsh the Michigan DNR needed to show among other things both the unique ecological character of the area and the destruction by unchecked development which is likely to continue if appropriate steps are not taken. A large share of the data used to make these points was derived from a set of 3 cover type maps of the marsh prepared by ERIM under the grant program.

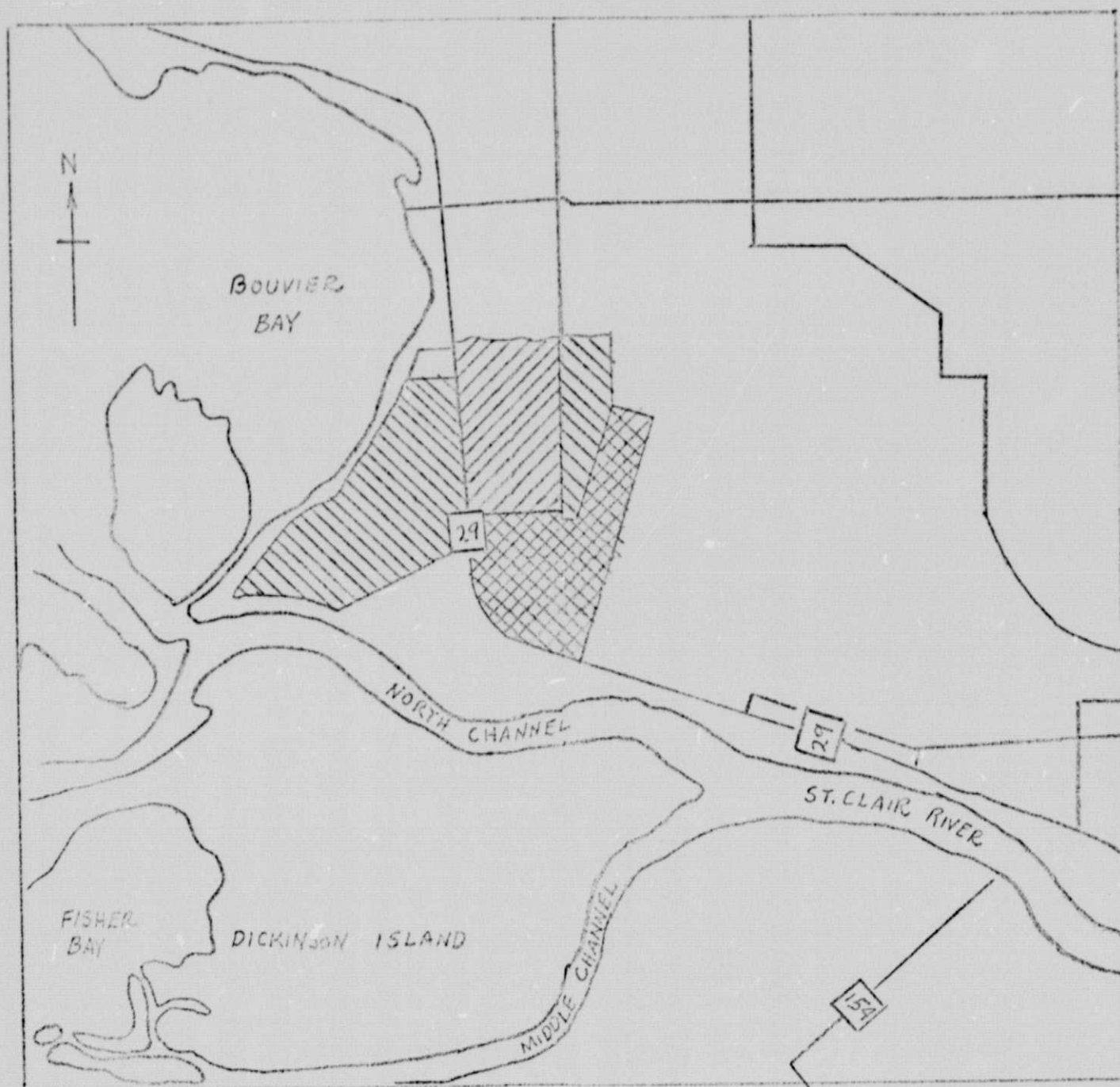
The historical character of the marsh was determined by interpreting 1938 ASCS airphotos. The marsh as it is today was mapped using a combination of NASA Michigan shoreline and U-2 high altitude air photos. A third map showing the changes between the two dates was also prepared. Statistics reflecting the data contained in the maps were also prepared.

In addition to the Duck Stamp and Heritage Fund monies, the Director's Office of the DNR is also attempting to accelerate acquisition plans by requesting emergency legislature appropriation funding from the State General Fund. Undoubtedly, ERIM's data will also be introduced here as justification for such a move. The Governor of



Michigan also strongly supports an accelerated program. In a letter to Executive Director John Sobetzer of the Eastern Michigan Environmental Action Council, the Governor says "Last July the Natural Resources Commission dedicated 3,000 acres as a Wildlife Area. It is my hope and desire that sufficient funds can be made available starting in the 1977-78 fiscal year to begin the systematic purchase of land inside the project boundary. We look forward to bringing this into public ownership and protection and only regret that funding of a project of this size must be done in installments."

It is anticipated that ERIM's data will be introduced in justifying emergency funding by the legislature. The data will also be of continuing use in later stages of the acquisition program.






-  First Priority (Ownership: St. John's Family)
-  Second Priority (Ownership: Blue Water Isles)
-  Third Priority (Ownership: St. John's Family)

FIGURE 1. 1977 ACQUISITION PRIORITIES FOR ST. JOHN'S MARSH

STATEWIDE WETLANDS PROTECTION

Several imminent events promise to significantly improve the approach to wetlands management and protection in Michigan. The most important of these is the almost assured passage next year of the "Wetlands Protection and Management Act." The bill that could create this act has been in the state legislature for the last two years, and only narrowly missed being enacted this year. Another important event is the work scheduled to be done in Michigan as part of the Federal National Wetlands Inventory.

An essential part of both programs will be the collection and analysis of remote sensing data to update our knowledge of the current status of the wetland resource. ERIM has continued to work with the state agency staff who will be responsible for the design and implementation of the inventory that will collect and analyze this remote sensing data. Our role so far has been one of explaining the pros and cons of available remote sensing systems, e.g., LANDSAT, aircraft MSS systems, and different types of aerial photography, recommending efficient survey strategies, and summarizing efficient data collection parameters for the different remote sensors. Much of this effort will bear fruit as early as next summer when it appears that 1:24,000 color infrared aerial photography of the Upper Peninsula will be collected.

New Legislation

On September 23rd, the Michigan House of Representatives passed substitute House Bill 4618, the Wetlands Protection and Management Act, in a landslide vote of 85 to 7. As presently written, the bill requires the Michigan DNR to first conduct a wetlands inventory and then prepare a management plan, both to be completed before prescribed wetlands use regulations are enforced. The bill calls for

the wetlands plan to include studies and research of wetland problems, provisions for a continuing inventory and a survey of existing wetlands management plans from the local to the federal level. In addition, the plan would recommend procedures for resolving user conflicts in wetlands.

The substitute bill contains several changes and was modified even further by several amendments. Especially significant were changes to the definition of wetlands, which now excludes bogs, vernal areas, and other wetlands not contiguous to lakes, rivers, and streams. An amendment added provisions which will allow the use of wetlands for storage of mineral waste (e.g., as tailings ponds) as long as these uses are carried out to encourage fish and wildlife habitation or some other equally valuable land use. Another amendment by the Farm Bureau delegating authority to local government for administering the regulatory program was also accepted.

At the time it was felt that these changes and amendments would draw support for the bill from Senator Joe Mack, Chairman of the Senate Conservation Committee and ensure a speedy review in his committee. This has not yet been the case, however, and the bill still has not been reported out. With no further committee meetings scheduled in 1976, it now appears that passage of the bill will not occur until 1977.

Aerial Photography of Forests and Wetlands

A potential source of data for the state wetlands inventory required by the bill is currently under development. The Land Resource Programs Division is coordinating the aerial photography requirements of several groups in an attempt to provide a single set of data that satisfy many users' needs at substantially reduced costs to any individual organization. Among these organizations that are actively contributing funds are the U.S. Forest Service, a group of private

forest industries in the Upper Peninsula and the DNR Forestry Division. Other state agencies such as the Highway Department and DNR Wildlife Division are also expected to support the program. At the Federal level, the Natural Wetlands Inventory is also interested.

Presently, the major uses of the photography are envisioned in the areas of forestry, land use and wetlands mapping. Both the Forest Service and Forestry Division will use measurements of trees and forest land area to update their inventories and management plans. The Land Resource Program Division intends to develop a computerized state land use data bank using the photography. If the state wetlands bill passes, this photography could be used to accomplish the required inventory. This same inventory data could also be used to meet the national wetlands inventory data needs.

At the urging of state representative Russell (Rusty) Hellman (D), plans have been accelerated so that data collection for the Upper Peninsula can be accomplished in the summer of 1977 and provide the forest industries of that area with badly needed current resource description data. The specifications for this photography have been developed by the Land Resource Programs Division. ERIM provided input to the development of these specifications by recommending photographic products which would optimize the potential for wetlands mapping. Other agencies and groups addressed the question of forestry and land use. The consensus was that 1:24,000 scale color infrared transparencies collected during the growing season were most useful for users concerned.

If things continue according to schedule it is anticipated that a request for bids to collect CIR photos of the Upper Peninsula will be issued in January 1977. Under the NASA grant, ERIM staff members will remain in contact with the developing program and provide consultation and advice on remote sensing procedures, as needed.

GREAT LAKES SHORELINE DATA APPLICATIONS

The Michigan Department of Natural Resources is continuing to use the shoreline recession rate measurement methods developed by the grant program, as reported in previous annual reports, as a basis for establishing zoning ordinances governing new construction along the shoreline. DNR has also discussed with HUD the possible use of recession rate data and measurements in connection with the responsibilities of the Federal Insurance Administration. ERIM is providing continuing consultation to DNR on uses of the NASA remote sensing coverage of the Michigan Shoreline obtained under the project.

Under separate funding by DNR, ERIM is also continuing its preparation of a shoreline atlas using this remote sensing coverage. This separate project is now about 75 percent complete and should be finished in 1977.

WASTE DISPOSAL SYSTEM OPERATION

The objective of this task is to identify overloaded or saturated tile fields, seeps, surface discharges, ponding, or other deficiencies associated with individual waste disposal systems.

Individual septic tank waste disposal systems have played a vital role in environmental sanitation. With appropriate consideration for soil conditions, land area, and setback, they provide a satisfactory method for wastewater disposal. On the other hand, poorly drained soils, high water table, deficiencies in size, and lack of maintenance can lead to intolerable conditions with respect to public health codes.

Our efforts have been directed toward assisting the Washtenaw County Department of Public Health. Working with public health officials, three problem areas were identified for which photography and other remote sensing techniques could be useful.

1. Many of the lakes located within the district exhibit water quality problems which are suspected to arise from faulty septic systems or possibly from direct discharges. High fecal coliform counts observed in the lake waters support this conclusion. However, these measurements made by the public health department are highly variable in time and location. While high counts indicate a problem, they do not generally identify the specific source which needs correction.

Low altitude color and color infrared photography is considered useful to identify suspected problem sites as manifested by signs of abnormal drainage from the tile field, high water table, and by the abundance of aquatic plant growths in the nearshore areas. Once identified, suspect sites can be further tested by dye tracer techniques.

2. Several of the small rural communities located within the county are suspected to have inadequate residential waste

disposal systems. Surface discharges of sewage or highly contaminated water have been observed from local drains to ditches and streams. While these drains may have originally been emplaced to handle stormwater, some local residences are connected directly to the line. To correct the problem, evidence is needed as to which residences are at fault. Aircraft infrared photography and thermal scanner imagery are considered to be useful to identify the residences at fault. During dry late summer periods, active tile fields are frequently easily identified on color infrared photography. Lack of an observable drain field and/or localized high moisture conditions near the road would support more complete on-site investigations. Thermal imagery collected at night during cold weather without snow cover could identify warmer discharge pipes as contrasted with surrounding surface soil temperature.

3. Current and planned rural subdivision development has put pressure on available ground water supplies. Alluvial aquifers used for well supplies are believed to be connected to shallow surface groundwater in areas of aquifer recharge. Contamination of well water supplied from septic tank flows could occur if housing development is allowed in recharge areas. Possible contamination can be averted if knowledge of these recharge zones becomes available. Presently little knowledge is available on groundwater recharge because of complexities in local soil conditions. High altitude infrared photography is considered useful to identify area drainage patterns and surface moisture supply conditions which may be indicative of recharge zones.

In response to the problem needs of the Public Health Department, low altitude color and color infrared aerial photography was collected for five area lakes and two rural communities. While the analysis is

not complete, several suspect cottage sites have been identified which will be followed up by the local sanitarian with on-site investigation to see if the septic system is functioning satisfactorily and meets minimum codes.

In addition, high altitude RB-57 infrared imagery is currently being examined from several previous flights for features which could help identify recharge zones.

Plans include further flights next spring in the lakes area to look for inundated septic systems.

MOSQUITO CONTROL TO REDUCE ST. LOUIS ENCEPHALITIS

The objective of this task was to make available remote sensing procedures to aid in mosquito control programs in Michigan. The primary reason for undertaking a program of mosquito control is to reduce the incidence of St. Louis encephalitis, a potentially fatal viral disease carried by mosquitos. The summer of 1975 marked the first occurrence of this disease in Michigan. Additionally, remote sensing could provide benefits in terms of dollar savings in current control programs devoted solely to the control of nuisance mosquitos. Remote sensing would also enable the use of control measures that do minimal damage to the environment by making such measures as the use of larvicides more specific.

The Tri-County Mosquito Control Commission was the principal agency involved with ERIM in this task. This agency is composed of six people, two from each County Board of Commissioners of Saginaw, Bay, and Midland Counties.

In 1975 Dr. Donald Newson, Associate Professor of Entomology at the Pesticide Research Center at Michigan State University, conducted a survey of mosquitos in Saginaw, Bay, and Midland Counties. This survey confirmed the fact that mosquitos which serve as vectors of St. Louis encephalitis are present in the Tri-County area and defined their habitats. The principal breeding sites are areas which were dry and subsequently become flooded, such as after heavy rains. Not all areas will contain the carriers of St. Louis encephalitis. With limited manpower to visit sites, a better means is needed to locate potential breeding grounds.

Detection of standing water is a well-documented capability of remote sensing. Determination of newly flooded areas using photo-interpretation of low-altitude black-and-white IR film would provide

control personnel with locations of areas to sample and/or apply specific control measures. Control may be done by draining or by using larvacides. Because breeding sites may be small in size, aircraft data are necessary. The size of the Tri-County areas and the fact that the mosquito breeding occurs in a matter of 7-10 days, makes control utilizing ground information alone a very difficult task.

The mosquito breeding season in the Tri-County area extends from about late May until frost (September). An initial photographic survey done in May (after the spring melt) serves as a base line against which subsequent surveys can be measured. After the initial base line survey, flights would be made only after any significant rainfall.

Based upon information on the amount and location of new standing water areas gained from a comparison between the base line survey and after-rainfall photographs, control personnel can pinpoint those locations which require sampling (of mosquito larvae to determine the presence of the encephalitis vectors) and possible application of control measures.

New bills in the State Legislature are now pending which will increase the Control Commission Authority for raising funds for the control of the disease. The use of remote sensing techniques is also considered as a means to respond to concerns of environmental groups by excluding areas where unnecessary control measures are taken.

The State of Michigan established a three-part surveillance program for St. Louis encephalitis (SLE) for 1976. This ties in with a nationwide SLE surveillance program run by the Center for Disease Control. Part one of the Michigan program is the identification of the breeding habitats and feeding habits of mosquitos in Southeastern Michigan. This portion of the program is headed by Dr. Newson. Part two of the Michigan program consists of testing wild birds and sentinel pheasants for SLE antibodies in the blood. (Birds serve as reservoir hosts for SLE; mosquitos must obtain the disease organisms from infected birds before they can infect humans.) The bird sampling is under the

direction of Dr. John Stuht of the DNR's Rose Lake Wildlife Research Center. Part three of the Michigan program is the careful monitoring of all human cases of encephalitis, with adequate lab work and follow up.

Most of the confirmed SLE cases in 1975 were in SE Michigan. Both the mosquito habitat studies and the avian testing are being concentrated here in 1976.

The following information has emerged from the program thus far:

1. Breeding sites of 3 mosquito species found to carry the SLE virus in 1975 in SE Michigan have been found to be the following in 1976:

Culex pipiens - roadside ditches and storm sewers (catch basins)

Culex salenarius - water with high inorganic salt content

Culex restuans - old tires

2. About 1000 avian serum samples were tested as of 6 August.
All were negative.

Based on this information it was decided that the likelihood of a severe SLE epidemic in 1976 was not great. The nationwide SLE newsletter indicates that this seems to be the case all over the U.S. However, the situation could change very rapidly. According to Stuht, the question of what could be done in an emergency has come up frequently in meetings of the people involved in the Michigan SLE surveillance program. There is no emergency plan.

It seems likely that remote sensing could be of value in an emergency situation, if the mosquito habitat and feeding information for SE Michigan does not change drastically from that reported above. We can detect tires on aerial photography. We might also be able to detect water in ditches and in catch basins on the same photography. Stuht feels that this would be of value. Based on this information ground crews could then eliminate water standing in tires and treat other areas of standing water with larvicides. Stuht feels that we could demonstrate

the utility of this approach using an area the size of a mosquito abatement district, 20-25 square miles. He planned to call ERIM in the event an emergency situation should arise. Fortunately, the outbreak of SLE which occurred in 1975 was not repeated in 1976. However, the analysis of the remote sensing application indicates that a fast response could be provided if a future outbreak threatens.

NATIONAL BACKPACK TRIP ALONG LAKE SUPERIOR

The Sierra Club is a national outing/environmental organization of 180,000 members in 63 chapters including 110 regional groups across the USA and Canada. A major part of the Club's outing program is conducted by the National Outing Committee, based at Club Headquarters in San Francisco, and with several regional sub-committees centered on areas affording quality outing experiences (e.g., New England, Rocky Mountain, and Midwest). The 1977 summer season program includes two National Trips scheduled by the Midwest Sub-Committee for the Upper Peninsula of Michigan. One of these is the "Superior Shoreline Knapsack Trek." This trip will start from Whitefish Pointe and the route will parallel the Lake Superior shoreline westward to Grand Marais, Michigan, a distance of about 50 miles, to be covered in six days of hiking.

The leader of this trip has hiked and scouted various segments of the planned route over the past 5 years, but has not had the opportunity to hike the total route in one trip. Much of the area to be covered is in public ownership, the largest acreage being in the Lake Superior State Forest. Scattered in-holdings of private ownership lands must be identified and avoided or permission must be obtained if the outing party wishes to traverse the property or camp on it. Currently, the best available editions of USGS topographic maps of the area were published in 1951 and 1968.

It was obvious to the trip leaders that these maps were out-of-date, both as to cultural features (especially roads, trails, and campgrounds) and to natural features (especially shifting river mouths and changes in lake levels on the Superior shoreline). The leader therefore inquired as to availability of more recent air photography at ERIM. It was explained that the photography would aid immeasurably in planning for the trip by providing information on which to identify

overnight camping sites, food drop sites, alternate routes, and problem sites. The NASA shoreline photography, taken in May 1974, covers the areas of interest and is proving to be useful to the trip leader. For example, with the aid of ERIM interpreters, some necessary route changes have been identified on stretches of the shoreline where high water has covered the beach and cut precipitous banks at the water line. One of the most important changes is the significant change in position of the outlet of the Sucker River-mouth Bay to Lake Superior (Figure 2).



FIGURE 2. AREA OF LAKE SUPERIOR BACKPACK TRIP

FRESH GRAVE DETECTION

In the field of crime detection, the problem of locating fresh shallow graves or buried objects is an urgent matter, even though the need arises only occasionally. ERIM has received inquiries from law enforcement agencies on this subject from time to time, but had never become actively involved. Our previous research on the use of thermal detection for shallow buried objects indicates that fresh shallow burials are usually thermally detectable, but the question arises as to whether these changes are sufficiently significant and predictable to permit reasonable detection probability within acceptable false alarm rates.

It would be of distinct value to law enforcement agencies to be able to detect fresh graves by thermal methods, and to understand the circumstances under which these methods can be successfully applied, as well as the equipment and procedures for applying them.

A capability for undertaking a search on short notice would represent an important addition to the ability of local law enforcement agencies to conduct criminal investigations.

ERIM therefore conducted under the NASA grant a small field study to demonstrate the detection of buried bodies. The results of this field investigation and conclusions as to operational feasibility were summarized and presented to local law enforcement agencies so that they are in a position to select this method where circumstances justify its use.

To demonstrate the capability of this technique, ERIM conducted a preliminary study utilizing a portable ground-based infrared imaging system (AGA Model 750 Thermovision). A local cemetery containing only surface gravestones was selected for the initial investigation in order to reduce thermal anomalies due to shadow.

Parameters which must be considered in determining the optimum time to look for signature differences include amount of and time duration since last rainfall, season, time of day, cloud cover, and terrain features. Under the proper conditions, three grave sites, ranging in age from four months to two years, were successfully detected.

The results were sufficiently encouraging to justify continued refinement of the application. Further consideration has been given to the applicability of an airborne platform for obtaining thermal images for grave detection. In general, the areas to be searched are large (hundreds of hectares), making the use of airborne remote sensing desirable.

As a result of this demonstration, the Ann Arbor Police Department requested ERIM's assistance in locating a buried body. Two bodies related to the same crime had been found previously, and the police were interested in investigating a suspected location in Lenawee County, near Adrian, Michigan. The Thermovision system was used to check the specific area both during the day and at night and detected an asphalt-paved area which appeared to be abnormally warm. As a result of this detection, the spot was dug up. However, the digging uncovered only plastic bags and tree stumps. Although the primary objective of the digging was not achieved, the thermal sensing system did in fact perform correctly, since its sole function is to identify areas in which the earth has been disturbed. The police are continuing their investigation and may ask for further assistance from ERIM, if additional suspicious areas are to be investigated.

MICHIGAN SPACE CENTER

ERIM is working with Charles E. Gass, Director of the new Michigan Space Center being constructed on the Jackson Community College campus, just outside Jackson, Michigan, to recommend suitable remote sensing exhibits for the Center. This Space Center has grown from a local effort to honor and commemorate Jackson natives who assisted in the U.S. space program into a State assisted display and research center for educational purposes, associated with and integrated into the facilities of Jackson Community College. The completed Space Center will contain a large display area, a 100 seat auditorium, offices, a gift shop and lounge area, all under a geodesic dome. A special library section will be maintained in the College library, containing films, slides, photographs and NASA reports. Special programs, displays and classes are currently being designed to develop the Center into a unique and exciting reflection of the technological accomplishments and future endeavors of man in outer space.

ERIM has provided Dr. Gass with examples of space photography and technical reports, with special emphasis on work done on Michigan test sites. We will continue to consult on methods of displaying remote sensing results of special interest for visitors to the Center.

INDUSTRIAL SITE SELECTION

The Office of Economic Expansion of the Michigan Department of Commerce has shown interest in the use of remote sensing data to assist its clients in the process of identifying and evaluating new industrial sites. One method of providing this information to the client is through the use of an industrial atlas for all parts of Michigan. This would provide a site location book to be shown to prospective clients as an easy and rapid method of identifying sites that would be suitable for various industrial purposes. NASA high-altitude color-IR photography, already available for many sections of Michigan, would meet this requirement very well. The photography could provide the client with a preliminary idea of the characteristics of the site, which could then be followed up by site visits. The atlas would include notations about site characteristics, transportation arteries, adjacent land use, etc.

ERIM has discussed this concept with Dr. J.F. Haneski, Director of the Development Programs Division of OEE and Mr. J. Kennedy, Sites Consultant in that Division. This discussion provided them with information on the characteristics of high-altitude photography, and methods of obtaining and annotating such photography. Mr. Kennedy is presently considering these suggested sources of remote sensing and methods of adapting them to use in an industrial atlas.